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**ORIGINAL ARTICLE**

# Study of Morphometric Analysis of Acetabulum and its Clinical Correlation

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## ABSTRACT

**Background:** Surgeon may learn more about the acetabular morphology and make a more accurate diagnosis of hip dysplasia by measuring the acetabular depth ratio. Understanding the intricacy and etiopathogenesis of illnesses like primary osteoarthritis of the hip joint etc. requires a thorough familiarity with the anatomical factors associated with this region.

**Objective:** To evaluate the morphometric analysis of acetabulum and its clinical correlation**.**

**Study Design:** Observational based study

**Study Setting:** This study was conducted in Department of Anatomy, Sharif Medical and Dental College, Lahore from July 2022 to December 2022.

**Methodology:** Using the teaching collection of the Anatomy Department, researchers examined 160 hip bones from adults with known sex. A set of digital vernier calipers was used to get all the measurements. Each variable was measured twice at separate times, and the mean of the two values was recorded. With no abnormalities in the morphology or moisture content of any of the chosen hip bones were included in the study. Osteoarthritic alterations, traumatic injuries, and skeletal diseases all led to specimen exclusion. SPSS version 20 was used for data analysis.

**Results:** All anatomical parameters of 160 hip bones were calculated in cm in which 76 (47.5%) were males and 84 (52.5%) were females. There was no statistically significant difference between the right and left sides of anatomical parameter ($p>0.05$). However, there were statically different in between gender. Males had a deeper acetabulum (2.8 cm) than females (2.6 cm). The acetabular diameter was statistically significantly larger in men than in females ($p=0.00$). The notched width in females was larger (2.75 cm) than in men (1.75 cm), and the capacity was more in males as compared to female. 96.7% of the bones had a pointed front and a lunate-shaped back. The form of the lunate at both the anterior and posterior ends is present in 3.3% of the cases.

**Conclusion:** In conclusion, by comparing male and female 20 to 47 years of age, the current research found statistically highly significant ($p<0.05$) differences in acetabular depth, diameter, capacity, and notch width. Ninety-three percent of the bones had a pointed front and a lunate-shaped rear. Just 5% of instances don't have the lunate shape at either the anterior or posterior ends. In order for orthopedic surgeons to accurately determine the diameter of the acetabulum during surgical operations, it is required to do a preoperative evaluation of the acetabulum's diameter.

**Keywords:** Acetabulum Diameter, Acetabulum Depth, Acetabulum Width, Acetabulum Capacity

## INTRODUCTION

The hip joint is a vital part of the body because it helps to distribute the body's weight evenly. The hip joint, a synovial joint, was once known as the ball and socket variant but is now more often known as rotating conchoids [(1)]. The acetabulum, from the Latin for "shallow vinegar cup," is a deep cup-shaped cavity on the lateral side of the hip bone formed by the fusion of the ilium (the upper part of the thigh bone), the ischium (the lower part of the thigh bone), and the pubis (the ball of the pelvis). It has both articular and non-articular components. The center floor, or acetabular fossa, is the non-articular, rough section. The articulating surface is termed the lunate. The body weight is transferred to the femur through the lunate, which has its broadest surface just above the point of weight bearing [(2)].

The hip joint relies on the acetabular cavity developing normally. During the fourth to sixth week of an embryo's development within the uterus, the cavity begins to form. Pre-cartilaginous patterning appears in the seventh week of pregnancy, and by the eighth week of development, the acetabulum has completed its development in its entirety [(3)]. When the femoral head is not adequately articulated inside the shallow acetabular cavity, a frequent congenital condition known as hip dislocation results. Thus, hip arthroscopy should be performed as soon as possible [(4)]. In clinical practice, acetabular prosthesis is built using morphometry of the acetabular fossa as a reference point. Orthopedic surgeons employ acetabular parameter measurements after surgery. Hip dysplasia and recovery were evaluated using acetabular and center edge angle, among other characteristics. Understanding the intricacy and etiopathogenesis of illnesses like primary osteoarthritis of the hip requires a solid foundation in anatomical characteristics [(5)].

The rim of the acetabulum is a ridge formed by the ilium, the ischium, and the pubis. The articular, or hip joint-forming, portion of this opening is termed the lunate surface, and the non-articular, or acetabular, fossa portion is called the acetabular fossa and is covered by a fatty pad [(2)]. Inferiorly (at the acetabular notch), the articular portion of the acetabular cavity is incomplete, with a sharp tip at its anterior end and a semilunar form at its posterior end. The hip joint's biomechanics rely on the acetabular cavity developing normally. During the fourth and sixth week of intrauterine development, the first signs of a cavity begin to appear. The pre-cartilaginous pattern is evident in the seventh week of pregnancy, and by the eighth week the acetabulum has developed completely [(6)]. Being one of the most frequent birth defects, acetabular dislocation is surprisingly prevalent. In cases with acetabular fossa underdevelopment, the femoral head does not fully articulate inside the acetabular cavity, leading to a shallow cavity [(7)]. Moreover, the roof is abnormally tiny and lacks articular surface, which is present at birth in this disease. When this happens, the joint cavity's roof experiences excessive stress whenever the person walks, leading to early deterioration. Hip arthroscopy is an absolute need in this case. In clinical practice, acetabular prosthesis is constructed using morphometry of the acetabular fossa as reference data. Acetabular parameter is a diagnostic tool used by orthopedic surgeons in the course of surgical therapy [(4, 8)]. For acetabular retroversion, some have postulated that the posterior acetabular wall is hypoplastic. Total hip replacement has always required extensive pre-operative preparation. The hip joint of the human body has been studied by morphologists, anatomist

etc. The sacroiliac joint is responsible for transmitting force to the hip, while the hip joint is responsible for transmitting force from the pelvis to the legs. Hip osteoarthritis may be influenced by ethnic variations in the overall anatomy of the hip joint [9].

Surgeon may learn more about the acetabular morphology and make a more accurate diagnosis of hip dysplasia by measuring the acetabular depth ratio. Understanding the intricacy and etiopathogenesis of illnesses like primary osteoarthritis of the hip joint etc. requires a thorough familiarity with the anatomical factors associated with this region [10]. For this purpose, this study is design for the analysis of morphometric of acetabulum and its clinical correlation.

## METHODS

**Study Design and Setting:** This observational based research was conducted at Department of Anatomy, Sharif Medical and Dental College, Lahore from July 2022 to December 2022. Using the teaching collection of the Anatomy Department, researchers examined 160 hip bones from adults with known sex. A set of digital vernier calipers was used to get all the measurements. Each variable was measured twice at separate times, and the mean of the two values was recorded.

**Inclusion and Exclusion Criteria:** With no abnormalities in the morphology or moisture content of any of the chosen hip bones were included in the study. Osteoarthritic alterations, traumatic injuries, and skeletal diseases all led to specimen exclusion.

**Sample Size Calculation:** On the WHO sample size calculator, a total of 160 subjects were chosen based on a prevalence of 26 % [11] hip abnormalities with 95% confidence interval and margin of error was 5%.

**Sex Determination:** Using seven visual characteristics of human hip bones, we were able to examine the gender each of the 160 hip bones. These standards included, the preauricular sulcus was palpated or shown to be an indentation on the sacropelvic surface of the ilium just below the auricular region. This was more pronounced in females and less noticeable or shallower in males. Second, the ilium and the ischium form the upper and lower boundaries of the larger sciatic notch, which is located posteriorly. After angling the rear edge of the hip bone forward by approximately 3 centimeters, it curves back and down to meet the back edge of the ischium. All of the bones were examined for the notch's breadth and the angle it makes with the backbone. The greater sciatic notch is more pronounced in females than in males. Third, both sexes have obturator foramens that are shaped similarly, located just below and somewhat anterior to the acetabulum. The obturator foramen was trapezoidal in females and oval in males. Fourth, males had a deep iliac fossa, while females had a shallow one. Both sexes were examined to see whether their ischiopubic rami were everted. Since the crus of the penis were attached to the ischium in the male, the ischium's ramus was everted, this never occurred in females. Fifth, ischiopubic ramus eversion was seen dorsally as a little bend in the ischiopubic ramus, not far below the pubic bone's lower edge. The female population had subpubic concavity, but males did not. Sixth, for the subpubic concavity, this was seen dorsally as a little bend in the ischiopubic ramus, not far below the pubic bone's lower edge. The female population had subpubic concavity, but males did not. And lastly, comparison between diameter of acetabulum and the distance of its anterior rim from pubic symphysis was performed so that the average size of the acetabulum in both sexes could be determined. In males, the acetabular diameter exceeded the anterior rim's distance from the pubic symphysis.

**Anatomical Parameters: Diameter of the acetabulum:** The space between the acetabulum's anterior and posterior walls, as measured by a digital vernier caliper.

**Depth of the acetabulum**: Maximum height from acetabular rim to central deepest point of acetabular fossa. A metallic scale was placed over the edge of the acetabular cavity to get the measurement.

**Width of acetabular notch**: The length of the articular region of the acetabulum that is formed like a lunate.

**Capacity of the acetabulum**: It's the capacity of the acetabular cavity. Plasticine was inserted into the acetabular cavity all the way to the brim's edge. The plasticine was then placed in a glass cylinder filled with water from a graduated measuring stick. Capacity of acetabular cavity was calculated based on the amount of water displaced.


Fig. 1: Measuring diameter & depth of acetabulum

**Statistical Analysis:** The data analysis for this study was carried out using version 20.0 of the IBM-SPSS. Descriptive analysis was performed on demographic factors such as age and gender. Independent t test was used to determine the mean and standard deviation of anatomical parameters. If the p-value was lower than 0.05, the data were considered to be statistically significant.

## RESULTS

All anatomical parameters of 160 hip bones were calculated in cm in which 76 (47.5%) were males and 84 (52.5%) were females. The acetabulum depths were equal on both sides (Right: 2.81 cm, Left: 2.80 cm). The right acetabulum diameters were measured at 5.23 cm and the left acetabulum is measured at 5.39 cm; these values are quite close to one another, indicating that they are of comparable size. There was no statistically significant difference between the right and left notch widths and capacity as well. (TABLE - II).

Table 1: Comparison of anatomical parameters based on sides

| Variables | Mean | Standard Deviation | P Value |
|---|---|---|---|
| Depth Right | 2.81 | 0.07 | 0.25 |
| Depth Left | 2.80 | 0.03 | |
| Diameter Right | 5.23 | 0.08 | 0.36 |
| Diameter Left | 5.39 | 0.18 | |
| Notch Width Right | 2.45 | 0.13 | 0.489 |
| Notch Width left | 2.59 | 0.02 | |
| Acetabular capacity right | 31.61 | 0.40 | 0.289 |
| Acetabular capacity left | 30.96 | 0.58 | |

Table 2: Comparison of anatomical parameters based on gender differences.

| Grouping | | Mean | Std. Deviation | P Value |
|---|---|---|---|---|
| Depth | Male | 2.81 | 0.07 | .036 |
| | Female | 2.61 | 0.03 | |
| Diameter | Male | 5.24 | 0.08 | .000 |
| | Female | 4.52 | 0.18 | |
| Notch | Male | 1.75 | 0.13 | .040 |
| | Female | 2.75 | 0.02 | |
| Capacity | Male | 31.61 | 0.40 | .002 |
| | Female | 28.47 | 0.58 | |

There were statically different in between gender. Males had a deeper acetabulum (2.8 cm) than females (2.6 cm). The acetabular diameter was statistically significantly larger in men than in females (p=0.00). The notched width in females was larger

(2.75 cm) than in men (1.75 cm), and the capacity was more in males as compared to female as presented in (Table -II).

96.7% of the bones had a pointed front and a lunate-shaped back (Fig. 3. A). The form of the lunate at both the anterior and posterior ends is present in 3.3% of the cases (Fig.3.B). It was found that 1.2% of the time the front and back were both pointed (Fig. 3. C).

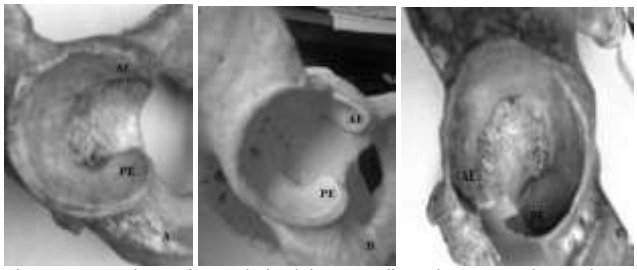

Fig. 2: Comparison of acetabular labrum endings (AE - Anterior End; PE- Posterior End)

## DISCUSSION

The hip joint is a synovial joint of the ball-and-socket type, making it one of the body's main joints. In addition to aiding in the discovery of disputed sex by forensic specialists, morphometric data of the acetabulum is crucial for clinical correlation. In addition, it aids orthopedic surgeons in preparing for complete hip replacement surgery [(12)]. The primary goal of this research was to highlight the value of acetabular morphometric data. Orthopedic surgeons may now accurately create geometric models and prosthetic implants with this information [(13)]. The acetabular diameter is a topic of research for a number of professionals. Males in the current research had a mean acetabular diameter of 5.24 cm, while females was 4.52 cm. As compared to the current research, the values reported by Edwards K et.al. [(14)] were higher, while the values reported by O'Rourke et al., are similar with ours [(15)]. This research found that the average acetabulum depth for men was higher than for females.

The synovial hip joint is one of the most important joints in the body and is of the ball-and-socket type. Analysis of the acetabulum's diameter and depth was performed by Archana et al., to aid in the creation of hip joint prosthesis, the identification of disputed sex by forensic experts, and the investigation of the causes of conditions such primary osteoarthritis [(16)]. According to Ding X et al., estimating the size of the acetabular cup in surgical operations of the acetabulum, particularly in total hip arthroplasty, necessitates evaluating the diameter of the acetabulum as part of preoperative planning [(17)]. The acetabular cartilage and labrum may be damaged in different ways depending on the anatomy of the hip. In a healthy hip, the labrum seamlessly connects to the acetabular cartilage in the transition zone. According to a study conducted by Wang Y et al., men in the North Indian population did not exhibit any statistically significant variations in average diameter between their right and left sides, but females were shown to have a smaller right side [(18)]. Several researches was considered on the acetabular depth a crucial metric for defining acetabular dysplasia [(19, 20)]. When the acetabular depth is less than 0.90 cm, the condition is known as dysplastic. It was found that congenital subluxation is more common in patients with a shallow acetabulum [(21)]. Klales, Alexandra R. found that the size of the fossa and the breadth of the notch, rather than the contour of the outer rim, were the defining characteristics of the sex differences in the depth of the articular surface. As women tend to have a more rounded pelvis, this might explain why there are noticeable disparities in acetabular depth and angle [(22)]. This research found that all anatomical parameter of gender difference is significant but non-significant according to the sides. Fossa size and notch width, rather than the contour of the outer rim, best described the sex variations in the depth of the articular surface.

## CONCLUSION

By comparing male and female 20 to 47 years of age, the current research found statistically highly significant ($p<0.05$) differences in acetabular depth, diameter, capacity, and notch width. Ninety-three percent of the bones had a pointed front and a lunate-shaped rear. Just 5% of instances don't have the lunate shape at either the anterior or posterior ends. Forensic experts will be aided by morphometric research in determining the identity of people of questionable sexuality. It will also aid in the process of making prosthetic devices. Complete Hip Replacement may take an advantage of the numerous acetabulum factors seen in the current investigation. In order for orthopedic surgeons to accurately determine the diameter of the acetabulum during surgical operations, it is required to do a preoperative evaluation of the acetabulum's diameter. Biomedical engineers will have a better chance of making a functional prostheses if they have a complete understanding of the differences between the sexes when it comes to the size of the acetabulum and the femoral head. This provides typical values for a range of metrics under conditions similar to those seen in patients on the operating table.

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